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IR-1609 (2-1941)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF APPEALS AND INTERFERENCES

In re Patent Application of

New York, New York

Daniel M. Kinzer

Date: May 5, 2003

Serial No.: 09/292,186

Group Art Unit: 2811

Filed: April 15, 1999

Examiner: S. Hu

For: P-CHANNEL TRENCH MOSFET STRUCTURE

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Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**APPEAL BRIEF UNDER 37 C.F.R. §1.192**

Sir:

This appeal stems from the Examiner's non-final rejection dated December 3, 2002, in connection with the above-identified application. The claims present in the application have been at least twice rejected. The Notice of Appeal was filed in the United States Patent and Trademark Office on March 3, 2003.

**Status of Claims**

Claims 1, 3-6, 8-13 and 20-22 are rejected and pending on appeal herein.

**Real Party in Interest**

The real party in interest is the assignee, International Rectifier Corporation.

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### **Related Appeals and Interferences**

The applicant, the assignee and the undersigned attorneys are not aware of any related appeals or interferences.

### **Status of Amendments**

All amendments have been entered, the last amendment being a response entered after the filing of an RCE dated September 4, 2002.

### **Summary of Invention**

The present invention is directed to a low voltage P channel power MOSFET with an epitaxially deposited N channel region having a constant concentration. The MOSFET has a trench type construction, in which the trenches extend into a P+ substrate, upon which the constant concentration channel region is deposited. The channel region adjacent the trenches receives P+ source regions atop the channel region bordering each trench. The invention obtains the advantage of a smaller on-resistance with a reduced channel length along which the concentration of N type material is constant. The resulting reduced on-resistance for the inventive device permits low power applications to reduce power losses by up to four times the amount experienced in conventional devices.

### **Issues on Appeal**

1. Whether claims 1, 3-6, 8-13 and 20-22 are rendered obvious under 35 U.S.C. §103(a) over the disclosure by Floyd et al. (U.S. Patent No. 6,090,716, the '716 patent) and knowledge generally available to one of ordinary skill in the art

### **Grouping of Claims**

The claims do not stand or fall together. Rather, there are three claim groups, the patentability of each group being subject to independent and separate consideration. These groups are

- I. Claims 1, 3 and 20;
- II. Claims 4-6, 8 and 21; and
- III. Claims 9-13 and 22.

### **Argument**

Briefly stated, it is Applicant's position that the Examiner has made an inappropriate finding of obviousness without considering unexpected results, problems to be solved in achieving the present invention that surpass the threshold of simple experimentation or design choice, advantages obtained by the present invention that are nowhere indicated or suggested in any of the cited prior art references and detailed evidence of widespread commercial success enjoyed by devices manufactured and sold in accordance with the description in the claims on appeal. It is also Applicant's position that the Examiner has not properly considered evidence of non-obviousness as is required of the Examiner. Applicant believes that proper consideration of the standards for obviousness and the evidence presented in support of non-obviousness indicate that the present invention recited in the claims on appeal is patentable over all of the cited prior art references.

Claims 1, 4 and 9 are independent. Claims 1, 3 and 20 of the first group recites a trench type power MOSFET with a vertical invertible channel composed of N type conductivity material. The invertible channel is positioned next to a MOSFET gate that can invert the conductivity type of the invertible channel. Claim 1 also states that the vertical invertible channel material has a constant concentration along its full length.

Claims 4-6, 8 and 21 of the second group recite a power MOSFET with an epitaxially deposited N type layer with a substantially constant concentration deposited on a substrate. A number of trenches are formed as gates for the power MOSFET that extend through the epitaxial layer, which limitation is not recited in the claims of group I. By extending through the epitaxially deposited N type layer, the trenches recited according to the claims of group II can obtain particular advantages with regard to turn on times and dispersion of minority carriers.

Claims 9-13 and 22 recite a power MOSFET with reduced on-resistance through the combination of a P type conductivity substrate, an epitaxially deposited N type conductivity layer atop the P type substrate that has substantially constant concentration throughout its volume, a plurality of spaced trenches with vertical walls extending through the N type epitaxial layer that have thin oxide layers on the vertical walls and the trenches are filled with P type conductive polysilicon. The group III claims stand together and separately from the other groups in that they call for the epitaxial layer to have a substantially constant concentration throughout its volume, in addition to having the advantages provided by trenches that extend through the epitaxial layer and thin gate oxide layers on the vertical walls of the trenches that are adjacent the P type conductivity material deposited into the trenches.

In the last Office Action, the Examiner takes the position that the '716 patent shows all of the features of the claims on appeal with the exception that the device disclosed in the '716 patent has a polarity that is the reverse of that described in the claims on appeal. The Examiner states in the Office Action that no prior art reference shows a device according to the claims of the present invention with a polarity type of PNP. However, the Examiner has stated a number of times that a MOSFET design which works under one polarity type is normally also workable under the reversed polarity. Although not used to reject the claims, the Examiner cites other prior art references by Floyd et al. (U.S. Patent No. 6,069,043, the '043 patent) and Darwish et al. (U.S. Patent No. 5,674,766, the '766 patent) for the proposition that devices with reverse polarity also normally work so that it would have been within the ordinary skill in the art at the time the invention was made to reverse the polarity of the device in the '716 patent to

obtain the device described in the claims on appeal. The Examiner also takes the position that the MOSFET device described in the '716 patent with a reversed polarity can inherently have a reduced on-resistance. The Examiner further states that it would have been obvious to make a MOSFET device with reverse polarity to that shown by Floyd with the channel area having a resistivity of about 0.17 ohm-cm and a thickness of about 2.5  $\mu\text{m}$ . The Examiner states no motivation for having a desired threshold voltage and on-resistance for the MOSFET in accordance with the claims on appeal, but rather considers the parameters to be obtainable through routine experimentation.

The basis for the Examiner's reasoning that a device that works under one polarity is also normally workable under an opposite polarity appears to infer that no other changes are necessary to obtain a reverse polarity device capable of achieving similar operation. Because the Examiner's position that reversing the polarity of the device is an obvious change, a person of ordinary skill would expect that reversing the polarity of the device would achieve similar operating conditions and advantages to that of the non-polarity reverse device. Otherwise, a straight polarity reversal should not be considered obvious due to further considerations required of one of ordinary skill in the art. That is, if there were a number of differences that had to be maintained between a device of one polarity type, and a device of an opposite polarity type, then polarity reversal cannot be said to be obvious because further effort and extensive experimentation would be required to determine the parameters of the polarity reversed device that matches the operational characteristics of the non-polarity reversed device.

By taking the view that polarity reversal is obvious, the supporting evidence provided by the Examiner should be expected to show similar operating characteristics between a device and its complement in polarity. However, the supporting evidence provided by the Examiner does not show a direct correlation between a device and its polar complement. Indeed, in each and every case in which a device has been constructed with a reverse polarity to that of its complement, significant and multiple changes are required to obtain operating features that are remotely similar in the original device. Applicant has repeatedly noted that one simple and

substantial difference is the mobility of carriers in materials of opposite polarity. It is well known to those of ordinary skill in the art that positive minority carriers have less mobility than their counterpart negative majority carriers. Accordingly, on this basis alone, a polarity reversal of a device would significantly change the characteristics of that device, and therefore make it an unobvious variation of the original device. The polar complement would be an unobvious modification to the original device because of the substantially different characteristics involved in operating device when the carrier mobility changes so significantly.

In the present invention, Applicant has focused on reduction of on-resistance with a P channel type unipolar field effect device. Applicant has shown a significant reduction in on-resistance in low voltage power applications, evidenced by comparison of the contents of the tables on pages 3 and 4 of the specification. Indeed, the reduction in on-resistance is by up to a factor of four times that of the prior art. Applicant has achieved these results by providing a constant concentration epitaxial layer for the channel region that has a specific dimension and resistivity. The advantages of the present invention recited in the claims on appeal have been achieved despite the fact that a P type channel device is used, i.e., the advantages of the present invention have been obtained even with a device having low carrier mobility.

The Examiner cites the disclosure by Floyd et al. (U.S. Patent No. 6,069,043) for the proposition that the device normally workable under one polarity is also normally workable under a reverse polarity. However, the disclosure by Floyd et al. shows a P channel device that is the complement of an N channel device, while stating that the P channel device has approximately the same dimensions and dopant concentrations as that of the complementary device. Applicant notes that the device disclosed in the '043 patent operates on a depletion basis, that is, the charge carriers are able to flow through a semiconductive region once opposite charge carriers are removed or depleted from particular regions of the semiconductor material. This is why the device disclosed by Floyd et al. has doped semiconductor material in the gate regions of the device that is of the same conductivity type as the body region. However, reversing the polarity of the disclosed device in accordance with Figure 11 of the disclosure in the '043 patent

would require significant changes to the structure of the depletion type device to achieve the same types of characteristics found in the N channel device. These substantial changes are necessary for a number of reasons, including the fact that the minority carriers have lower mobility in the device, resulting in a higher threshold voltage for the P channel device, in addition to increased switching times and increased on-resistance. However, none of these parameters are mentioned in the disclosure of the '043 patent. Instead, the Examiner merely states the conclusion that the devices would be workable under a reverse polarity. Such a conclusion ignores the advantages and differences in the devices that have opposite polarity, which differences can only be perceived through additional experimentation. Accordingly, a reversal of polarity for a device does not provide a straightforward solution that is merely an obvious variation of a given device, but rather produces a number of engineering, design and experimental challenges to produce a device according to a specific criteria, that otherwise may have been easily met with the device of the opposite polarity. In this regard, the present invention recited in the claims on appeal has produced unexpected results, as has been clearly indicated in the specification of the present invention. However, while Applicant has noted these results numerous times as unexpected, the Examiner has not addressed this issue. Instead, the Examiner has merely continued to state that polar inversion produces an obvious variation, without noting the advantages or difficulties of inversion. Accordingly, the Examiner has failed to consider evidence of unexpected results presented by Applicant, as is required, but instead cites other prior art that does not show unexpected results.

Referring to the disclosure by Darwish et al., the only relevant statement in the entire document provides that the disclosed invention is applicable to N channel as well as P channel MOSFETs. This statement again fails to illustrate the numerous differences and difficulties encountered in modifying a given device to have a reverse polarity. In the last response, Applicant submitted a declaration by Ritu Sodhi, a design engineer with abilities at least within the ordinary skill in the art, to indicate the difficulties and design considerations that must be undertaken in producing a P channel device, which does not easily flow from the

knowledge obtained about N channel type devices. A straightforward example is given with regard to the different types of dopant material used to produce N channel and P channel type devices. For example, the boron used to produce a P channel type device outdiffuses into the N type epitaxial region much more readily than the arsenic used to form an N channel device would diffuse into the corresponding P type region. The operational characteristics of the P channel MOSFET is defined by the epitaxial channel, so that any variation in the construction of the P channel device directly impacts blocking capability and threshold voltage. In addition, polysilicon doping must be carefully controlled to obtain an appropriate threshold voltage in the P channel device. The same is not true of the corresponding opposite polarity N channel device.

The above evidence supplied by one of ordinary skill in the art provides evidence of fundamental differences between the construction of a P channel device and an opposite polarity N channel device. When coupled with the other evidence supplied in the application regarding unexpected results, as indicated in the tables on pages 3 and 4 of the specification, and the fact that carrier mobility is significantly different between a device and its complement, it cannot be easily said or readily assumed that a device that is workable under one polarity type is also straightforwardly or obviously changed to produce an opposite polarity device. At the bare minimum, there are important differences between a device and its complement that warrant the Examiner in the present case to consider any evidence of non-obviousness.

However, the Examiner has consistently refused to consider the evidence provided by Applicant of unexpected results, advantages that are obtained over the prior art that are unsuggested by the prior art and evidence that the device according to the claims of the present invention could not be obtained from the prior art disclosures without undue experimentation. Instead, the Examiner simply restates the argument that it would have been obvious to one of ordinary skill in the art to reverse the polarity of a prior art device to obtain an obvious variation claimed in the present application. The Examiner cites a number of premises in support of this position, but repeatedly fails to consider or address the evidence of unexpected results, advantages provided by the present invention that are unsuggested in the prior art and the factual



support for the premise that the present invention cannot be achieved based on prior disclosures without undue experimentation. All this evidence and support have been repeatedly brought to the attention of the Examiner in prior responses and declarations that are a part of the record in the application, without any response or comment from the Examiner. The Examiner's position is maintained apparently without regard for the mandate that the Examiner must consider evidence by the Applicant showing unexpected results in the traversal of the rejection. MPEP §716.01(d), In re Odtiker, 24 USPQ2d 1443 (Fed. Cir. 1992). Any rebuttal evidence in a *prima facie* case of obviousness must be evaluated along with the supporting evidence on which the *prima facie* conclusion was reached. In re Eli Lilly, 14 2SPQ2d 1749 (Fed. Cir. 1990). The Examiner's consistent refusal to consider these results and to maintain the simple argument of obviousness of a reversal in polarity based on assumption rather than any documented supporting evidence goes directly against well established practices in the USPTO and relevant case law cited above.

The Examiner also takes the position with regard to claims 4 and 5 that if the device disclosed in the '716 patent were reversed in polarity, it would have an inherently reduced on-resistance. Applicant notes that this position is unsupported by any factual evidence. Applicant further notes that the reversal of polarity of an N channel device, as disclosed in the '716 patent, has an **inherently increased** on-resistance for all of the reasons stated above with regard to P channel type devices. That is, P channel type devices have lower carrier mobility and other difficulties with processing parameters such that a P channel device would inherently have increased on-resistance, in addition to other unwanted characteristics such as increased threshold voltage and decreased switching time. The Examiner has provided no evidence whatsoever in support of the conclusion that an enhancement type P channel unipolar field effect device has exactly the same characteristics as those of an enhancement type N channel device, or that the characteristics are in any way improved. Indeed, it appears from the Examiner's statement in the Office Action that the device in the '716 patent, if reversed in polarity, would have different characteristics, i.e., an inherently reduced on-resistance. Applicant believes that it is

inappropriate for the Examiner to take one position with regard to obviousness to reverse the polarity of a device, and then state that there are a number of differences and advantages obtained with the reverse polarity device.

The Examiner also takes the position that the parameters recited in claims 8 and 11-13 are obvious to one of ordinary skill in the art and can be obtained without undue experimentation. However, the Examiner bases this premise on the supposition that it would be obvious to reverse the polarity of one device and obtain the same operating characteristics as the non-polarity reversed device. That is, if the Examiner believes that it would have been obvious to arrive at the parameters recited in claims 8 and 11-13 for an N channel type device, then according to the Examiner's position, there would follow the same parameter values for a P channel type device with a simple reversal in polarity. However, this position is clearly problematic, as the Examiner calls for modifying several variables at once to arrive at obvious results. However, Applicant has repeatedly argued and shown with clear supporting evidence, that modification of one or more parameters produces unexpected results. That is, the inventors have described particular parameter values and ranges to achieve the best embodiment of a P channel type device, and have shown with extensive evidence that the same parameter values would not be applicable to an N channel type device. Indeed, it should be apparent that a great deal of experimentation and effort would be required to understand the parameter values to optimize a reverse polarity device given the parameters of a non-polarity reversed device. This evidence is supplied in the specification of the present application, in addition to the statements made by Ritu Sodhi in the declaration accompanying the most recent response in the application. Accordingly, the Examiner's position with regard to obviousness of the claimed parameter values is at odds with the premise that it is obvious to reverse the polarity of a given device to obtain the same operating characteristics and parameters.

In addition, Applicant notes that the Examiner makes a broad assumption regarding the parameter values in that they are merely assumed to be the result of routine experimentation or optimization. As Applicant has stated previously and steadfastly, the present

invention produces a number of unexpected results that are directly and indirectly related to parameter value selection, as has been shown in both the specification and declaration accompanying the most recent response in the application. In contrast, the Examiner has provided no evidence of obviousness for the claimed parameter values. With regard to a finding of obviousness, the Examiner must provide evidence that as a whole shows that the legal determination sought to be proved (i.e., the reference teachings establish a *prima facie* case of obviousness) is more probable than not. MPEP §2142. The Examiner has provided no evidence of obviousness, but merely states that the claimed values are well within the commonly recognized ranges for the relevant parameters, i.e., the conclusion sought to be proved. Without any supporting evidence, Applicant respectfully submits that a *prima facie* case of obviousness should not be established.

In the most recent response submitted in the application, Applicant provided a declaration by Ritu Sodhi, who is an expert in her field and certainly in possession of knowledge within the ordinary skill in the art. These facts support the statements in the declaration showing the declarant's education, background and experience in the relevant field. In her declaration, aside from noting the significant differences attendant with producing a P channel type device as opposed to an N channel type device, the declarant notes sales information related to devices constructed according to the claims on appeal for the present application. In paragraphs 9 and 10 on page 3 of the declaration, sales figures and volume for the device covered by the claims presently on appeal are provided to show clear evidence of commercial success. The total sales revenue for devices covered by the claims on appeal is in excess of \$6,000,000.00. The total volume of devices covered by the claims on appeal exceeds 32,500,000. Applicant respectfully submits and declarant respectfully avers that these figures indicate clear evidence of commercial success of the device of the present invention falling within the scope of the claims on appeal. Indeed, the products covered by the claims on appeal are among the more popular sold by the assignee, International Rectifier Corporation. The popularity of these products for low voltage power applications is clearly echoed in the sales data

provided, due to the recognition of customers of the advantages obtained in the invention for reduced on-resistance with a simpler design and construction than that found in the prior art. Applicant respectfully submits that even if it were obvious to reverse the polarity of the prior art device disclosed in the '716 patent, no manufacturer has done so to date, but would have been clearly motivated to do so based on these sales and volume figures alone. Accordingly, the data submitted by Applicant tends to support an argument for meeting a long-felt-need. All this supporting evidence of non-obviousness taken together clearly shows the advantages of the present invention recited in the claims on appeal.

Nevertheless, the Examiner takes the position that these sales figures and evidence of commercial success are meaningless. Indeed, the Examiner refuses to consider this evidence, and instead compares the inventive advantages of the device in the present invention to an ornamental design. The Examiner cites three federal cases for the proposition that evidence of commercial success must be attributable to the ornamental aspects of a design rather than functional elements. Avia Group Int'l Inc. v. L.A. Gear California, Inc., 7 USPQ2d 1548 (Fed. Cir. 1988); In re Nalbandian, 211 USPQ 782 (CCPA 1981); Litton Systems, Inc. v. Whirlpool Corporation, 221 USPQ 97 (Fed. Cir. 1984). In each of these cited cases, the Examiner draws on court findings that evidence of commercial success has minimal value if no connection is shown to the ornamental features of the design.

Applicant strongly contests these citations and findings with regard to evidence of commercial success. It should be clear that the present invention is not sought to be patented for ornamental features. Instead, the present application is for a utility patent. There have been no claims made to the ornamental features of the present invention. Accordingly, the cases cited by the Examiner are inapplicable to the issues at hand.

As noted above, with regard to evidence of unexpected results, the solution to problems that would otherwise require tremendous amounts of undue experimentation based on the prior art and the advantages obtained over the prior art that are not suggested in any of the prior art references, the Examiner again refuses to consider evidence as mandated. Applicant has

provided clear evidence of commercial success and market popularity, however, the Examiner has failed to note the significance of this evidence, and indeed fails to address it at all. Applicant submits that the present invention recited in the claims on appeal should be patentable over all of the cited prior art references on the basis alone of evidence of commercial success presented by the Applicant, once the evidence is properly considered.

In view of all the foregoing evidence and discussion, it is respectfully submitted that the Examiner has improperly applied the standards required to determine obviousness and has not considered the significant and well documented evidence in support of non-obviousness, as is mandated. Applicant further submits that on proper application of the standards for obviousness and consideration of the evidence presented in support of non-obviousness, claims 1, 3-6, 8-13 and 20-22 are allowable over the cited prior art references and the knowledge available to one of ordinary skill in the art. Accordingly, Applicant respectfully requests that the Examiner's rejection of claims 1, 3-6, 8-13 and 20-22 be reversed and that the application be passed to issue. Applicant notes that claims 3 and 20 depend upon claim 1 and should be allowable over the cited prior art references for the same reasons that claim 1 is allowable as well as because of the combination of features set forth in claims 3 and 20 with those provided in independent claim 1. Applicant therefore respectfully requests that the decision of the Examiner rejecting claims 3 and 20 under 35 U.S.C. §103(a) over the cited prior art references and the knowledge available to one of ordinary skill in the art be reversed and that the application be passed to issue.

Applicant further notes that claims 5-6, 8 and 21 depend upon and further limit claim 4, while including all of the subject matter of claim 4. Accordingly, these dependent claims should be found allowable over the cited prior art references for the same reasons that claim 4 should be found patentable, and in addition for the separate features set forth in each of the dependent claims in combination with independent claim 4. Applicant therefore respectfully requests that the decision of the Examiner rejecting claims 5-6, 8 and 21 under 35 U.S.C. §103(a)

in view of the cited prior art references and knowledge available to one of ordinary skill in the art be reversed and that the application be passed to issue.

Applicant also notes that claims 10-13 and 22 depend upon and further limit claim 9, while including all of the subject of claim 9. Accordingly, Applicant submits that claims 10-13 and 22 are allowable over the cited prior art references for the same reasons as claim 9, and in addition for the reason of the further limitations found in each of the dependent claims in combination with the independent claim 9. Applicant therefore respectfully requests that the decision of the Examiner rejecting claims 10-13 and 22 under 35 U.S.C. §103(a) in view of the cited prior art references and the knowledge available to one of ordinary skill in the art be reversed and that the application be passed to issue.

#### **Conclusion**

In view of the foregoing discussion and evidence presented, it is respectfully submitted that claims 1, 3-6, 8-13 and 20-22 are clearly patentable over the cited prior art references and the knowledge available to one of ordinary skill in the art. Applicant therefore respectfully requests that the Examiner's rejection of claims 1, 3-6, 8-13 and 20-22 be reversed and that the application be passed to issue.

Our check No. 15858, which includes the amount of \$320.00 to cover the appeal brief is attached hereto. This brief is being submitted in triplicate in accordance with 37 CFR 1.192 and Applicant reserves the right to request an oral hearing upon receipt of the Examiner's Answer.

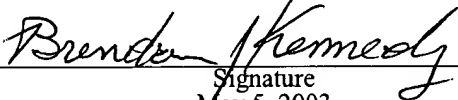
If this communication is being filed after a shortened statutory time period has elapsed and no separate Petition is enclosed, the Commissioner of Patents and Trademarks is petitioned, under 37 C.F.R. §1.136(a), to extend the time for filing the required papers by the number of months which

will avoid abandonment under 37 C.F.R. §1.135. The fee under 37 C.F.R. §1.17 should be charged to our Deposit Account No. 15-0700.

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Mail Stop Appeal Brief-Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA, 2233-1450., on May 5, 2003

Brendan J. Kennedy

Name of applicant, assignee or  
Registered Representative

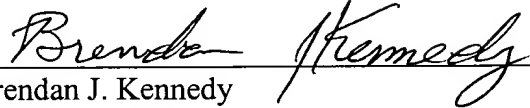


Signature

May 5, 2003

Date of Signature

Respectfully submitted,



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## APPENDIX

The Claims on Appeal Are:

1. A trench-type power MOSFET having a vertical invertible channel composed of N type conductivity material and disposed between a source region and a drain region; a gate oxide and gate contact thereon extending along the length of said invertible channel and operable to invert the conductivity type of said invertible channel; said gate contact containing a P type conductivity material; said vertical invertible channel material having a constant concentration along its full length.
3. The power MOSFET of claim 1 wherein said invertible channel material is epitaxially deposited silicon.
4. A power MOSFET comprising, in combination, a P type substrate; an epitaxially deposited N type layer deposited atop said substrate and having a substantially constant concentration; a plurality of spaced trenches having vertical walls extending through said epitaxial layer; a thin gate oxide on said vertical walls and conductive P type polysilicon deposited into said trenches to define a polysilicon gate; a P type source region formed adjacent the walls of each of said trenches and diffused into the top of said epitaxial layer; a source contact connected to at least said source regions; a drain contact connected to said substrate; whereby said MOSFET has a reduced on resistance.
5. The MOSFET of claim 4 wherein said source contact is connected to said source region only, whereby said MOSFET is bidirectional.



6. The MOSFET of claim 4 wherein said source contact is connected to said epitaxially deposited layer.

8. The MOSFET of claim 7 wherein said epitaxial region has a resistivity of about 0.17 ohm cm and a thickness of about 2.5  $\mu\text{m}$ .

9. A power MOSFET having reduced on resistance comprising, in combination; a P type conductivity substrate; an epitaxially deposited N type conductivity layer deposited atop said P type substrate to form an epitaxial layer having a substantially constant concentration throughout its volume; a plurality of spaced trenches having vertical walls extending through said epitaxial layer; a thin gate oxide on said vertical walls and conductive polysilicon with a P type conductivity deposited into said trenches to define a polysilicon gate; a P type concentration source region formed adjacent the walls of each of said trenches and diffused into the top of said epitaxial layer; a source contact connected to at least said source regions; and a drain contact connected to said substrate.

10. The MOSFET of claim 9 wherein said source contact is connected to said epitaxially deposited layer.

11. The MOSFET of claim 10 wherein said epitaxial layer has a resistivity of about 0.17 ohm cm and a thickness of about 2.5  $\mu\text{m}$ .

12. The MOSFET of claim 9 wherein said substrate is a P<sup>+</sup> substrate having a resistivity of less than about 0.005 ohm cm.

13. The MOSFET of claim 10 wherein said substrate is a P<sup>+</sup> substrate having a resistivity of less than about 0.005 ohm cm.

20. A trench-type power MOSFET according to claim 1, further having highly doped contact regions at a top portion of said vertical invertible channel.

21. A power MOSFET according to claim 4, further comprising highly doped contact regions in said epitaxial layer.

22. A power MOSFET having reduced on resistance according to claim 9, further comprising highly doped contact regions in said epitaxial layer.